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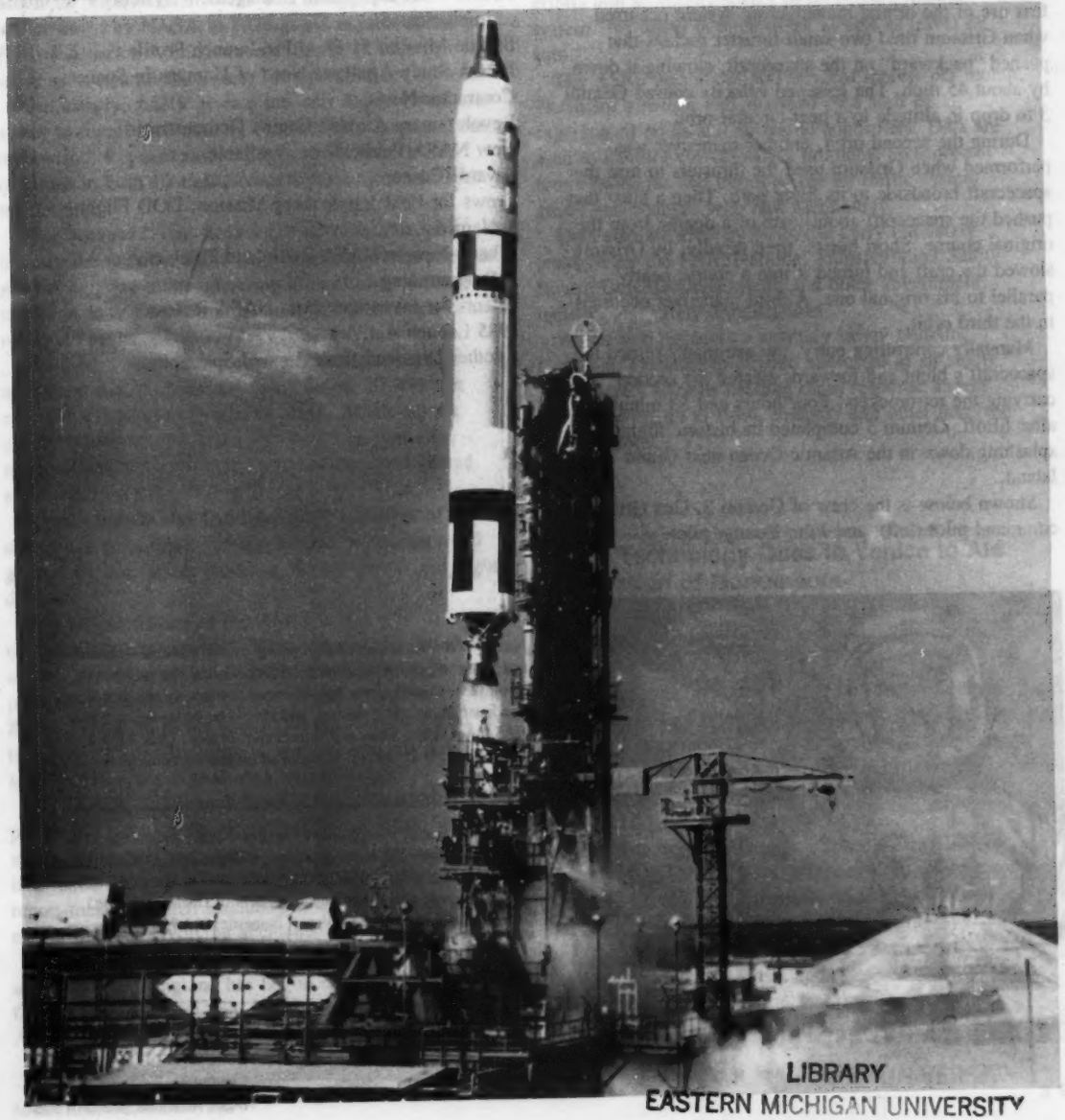

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## About the Cover

March 23 marks the 20th anniversary of the launch of Gemini 3, the first U.S. two-man spacecraft. Boosted by a two-stage Titan II vehicle, the "Molly Brown," carrying astronauts Virgil I. "Gus" Grissom and John W. Young, was successfully launched at 9:24 a.m. EST, from the Eastern Test Range at Cape Canaveral, Fla.

Within six minutes after liftoff, Gemini 3 was injected into an elliptical orbit with a speed of 16,000 miles per hour. Toward the end of the first orbit, the first use of the orbital maneuvering system occurred when Grissom fired two small thruster rockets that pushed "backward" on the spacecraft, slowing it down by about 45 mph. The lessened velocity caused Gemini 3 to drop in altitude to a near-circular orbit.

During the second orbit, another maneuver was performed when Grissom used the thrusters to turn the spacecraft broadside to its flight path. Then a burst that pushed the spacecraft about 1/50th of a degree from the original course. Short bursts, fired rapidly, by Grissom slowed the craft and turned it into a course nearly parallel to his original one. A third maneuver occurred in the third orbit.

Manually controlling entry, the astronauts turned the spacecraft's blunt end forward, ejected the section carrying the retrorockets. Four hours and 53 minutes after liftoff, Gemini 3 completed its historic flight, splashing down in the Atlantic Ocean near Grand Turk Island.

Shown below is the crew of Gemini 3, Gus Grissom, command pilot (left); and John Young, pilot.

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## NASA's Aviation Reporting System Improves Aircraft Safety

NASA's anonymous and voluntary Aviation Safety Reporting System (ASRS) in eight years has evaluated some 42,000 incident reports, and issued 805 alert bulletins and 28 research reports to further improve safety in the airways.

"We believe that ASRS reports have eliminated serious hazards and saved lives," said William Reynard, program manager at NASA's Ames Research Center, Mountain View, Calif. ASRS was designed and implemented by NASA in 1976 at the request of the Federal Aviation Administration (FAA). NASA was to serve as "a neutral third party" in operating the system.

"Put simply, ASRS gives pilots and flight controllers a way to report incidents we'd never have known about otherwise," Reynard said. ASRS reports have led to revisions in both air traffic control procedures and FAA regulations.

"For instance," said Reynard, "we were able to identify the need for more help from flight controllers to general aviation pilots operating at night over unfamiliar terrain in providing warnings of such terrain hazards as mountain peaks.

"In another example, cockpit conversations and activity in transport aircraft flying below 10,000 feet now are restricted to flying the plane. ASRS reports clearly showed that random conversations and other non-essential activity during times of heavy workload are dangerously distracting."

System reports also have produced a number of changes in pilot flight training for airline, military and general aviation pilots based on the additional real flight data.

A principal feature of the ASRS is that it is confidential and voluntary. When a hazardous incident occurs, participants can "tell it to the ASRS" without personal embarrassment or fear of incrimination. Reports and data in the system do not include names or revealing details. The reports, nonetheless, do give specific examples of real situations to avoid.

NASA acts as a knowledgeable but neutral third party. This protects the confidentiality of pilots, air traffic controllers and others desiring to share safety information. To encourage reporting, FAA grants to report-makers limited immunity from disciplinary action except in cases involving accidents or criminal conduct.

The system has become a model for other countries and industries. England has begun such a program and Canada is developing one. Other countries have used ASRS data to design and organize safety systems. The ASRS concept of voluntary, confidential incident reporting is under study by the U.S. Nuclear Regulatory Commission, the Department of Transportation and other government and industry groups.

The 40,000-item ASRS data base has become a major resource for various human factors research. Its unique quantity and detail of material can be used to formulate behavior models and provides insights into many human situations.

Reynard cites studies which say that, for every accident, an average of 600 unsafe incidents take place. But Reynards points out that ASRS and other air safety efforts aim at improvements in an already reliable system. Air travel is three times as safe as travel by auto.

The ASRS gets about 500 incident reports per month. These are screened and analysed by a staff of experienced pilots and air traffic controllers. Data are used to identify current safety problems and forecast future problems and trends as the air traffic system grows and changes with new technology.

Data also are used by NASA to carry out safety research for the FAA; National Transportation Safety Board; Defense Department; and other government, industry and safety organizations.

ASRS also produces a monthly safety bulletin, *Callback*, available to anyone interested in air safety. When safety hazards needing rapid response appear, alert bulletins go to FAA, industry and other involved organizations.

## Space Technology Goes to Venice to Aid Restoration of Monuments

Space technology developed for mapping the chemical composition of the moon and planets is being tested in Venice as a new means of understanding the decomposition of priceless monuments. The tests are part of an international effort to apply the most modern methods available to saving the city's historic buildings as Venice continues to sink slowly into the Adriatic Sea.

Scientists from the Goddard Space Flight Center in Greenbelt, Md.; Computer Sciences Corp., Silver Spring, Md. and the University of Maryland, College Park, last summer tested the use of a gama ray detector to map salt and water seeping into the walls of the famous St. Mark's Basilica and the Gradenigo Palace. The detection system is the first non-destructive technique to date for detecting the often invisible rise of

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saltwater within the interior of building walls and for mapping the deposits of salt which gradually decompose their materials. Because water damage is common to many architectural monuments beyond those in Venice, the new technique could also be useful in helping preserve other historic trusts around the world.

Previous techniques have used drilling for core samples which had to be used sparingly to date for fear of further damaging endangered walls and frescoes. By using neutrons instead of drillbits to explore the wall interiors the gamma ray detector offers a fast and comprehensive look at damaged structures, permitting building restorers a way to better plan and focus repair efforts.

Dr. Jacob Trombka of Goddard's Solar Physics Branch, a member of the investigators group, developed the X-ray and gamma ray detection techniques in 1968 as part of an effort to map lunar soil during the Apollo program. Recognizing that the lunar soil continuously releases gamma radiation as it is naturally bombarded by cosmic rays in space, the Apollo remote sensing X-ray and gamma ray team proposed a detection system which was included aboard the Command Service Module to record patterns in the lunar soil's gamma ray and X-ray emissions. Such patterns provide a reflection of the elements composing the soil, as each element tends to give off a characteristic "signature" of X-ray and gamma radiation.

"Between 1968 and 1972, we mapped 20 percent of the lunar surface this way," says Trombka. "Then with the completion of the manned lunar program, we began looking for ways that we could spinoff some of the technology we had found so useful in exploring the moon to solving problems here at home."

In the mid-1970s, Dr. Larry Evans, Computer Science Corp., joined Trombka to extend these systems for future planetary missions and to adapt the detection technique to Earth, where cosmic rays do not penetrate the atmosphere sufficiently to stimulate natural gamma emissions. The immediate solution was to apply neutron excitation methods to simulate gamma ray emissions. Using low intensity neutron sources, prompt gamma ray emissions could be detected, thus reducing the radiation hazard by leaving the sample with negligible residual radioactivity. This method, called "prompt neutron gamma ray analysis for application to analysis of extended materials" proved so successful that its developers patented the technique in 1984.

Trombka and Evans first applied the gamma detector to an architectural site in 1981, when arrangements were made by Richard Livingston of the University of Maryland and Thomas Taylor of Colonial Williamsburg Foundation to test it on the walls of an 18th century smokehouse in Williamsburg, Va. The Williamsburg preservationists had discovered the bricks of the smokehouse were being damaged by salt deposits. They needed a device for measuring the salt water content in the walls before and after they applied a remedy in order to be sure they had found the correct solution.

The neutron gamma detection system not only proved its worth by successfully measuring the salt content, it also discovered salt higher in the walls than ground water could have deposited it. This led to the realization that the salt could date back to the use of the building for smoking and curing meats, a condition calling for quite a different ultimate solution than a groundwater problem. Thus the tool also proved its usefulness as a diagnostic device for finding problems and identifying solutions.

So successful was the test, in fact, that Richard Livingston mentioned the device to Italian colleagues working to preserve historical buildings in Venice. Dr. Roberto Frassetto, the head of the Interlaboratory Group of Scientists the Venice restoration effort, subsequently invited Trombka, Evans and Livingston to the city for a two-week test in November 1984. The travel was supported by a collaborative research grant from the NATO Science Committee.

The measurements were carried out with a team of scientists from the Italian Nuclear Agency led by Drs. Mauritzio Diana and Pietro Moioli. Placing the detector on one side of a wall, and a neutron source on the other to briefly irradiate the intervening material, the investigator group sampled walls in a variety of Venice's most famous structures. At St. Mark's Basilica, for example, the technique provided the first picture of conditions as deep as 20 inches inside walls which were faced with marble or precious frescoes.

Now back at Goddard, Trombka, Evans and Livingston are analyzing the readings made in Venice to fine tune their approach for further tests in 1985. At the same time, they are sharing their analysis techniques with Italian colleagues to transfer the technology.

If tests continue to be as promising as to date, says Trombka, the detector could be ready to join the Venice restoration operationally in as little as another year. This would meet the restorers plans to compile a city-wide survey of conditions in Venice beginning in 1987. For the city-wide survey, Frassetto (of Italy's the Consiglio Nationale delle Richerche) hopes to compile a battery of high-technology techniques including Infra-red Thermography and ultrasonics to replace traditional reliance on core sampling. Frosetto plans to visit Goddard in January in hopes of finding additional space-based technologies applicable to the task.

Meanwhile, the remote sensing gamma ray detector

system itself may soon be returning to space. In 1990, it is planned that the detector will fly aboard NASA's Mars Observer, a mission to orbit a satellite about Mars to study the planet's surface composition, atmosphere and climate, Through the relatively thin atmosphere, the detector will be able to profile soil constituents as they are excited by natural cosmic rays striking the planet.

Additionally, NASA is eyeing a proposal for a cometary rendezvous for launch in the early 1990s which may also carry a gamma ray detector. The proposal now under review as a future flight project suggests plunging a penetrator probe into the nucleus of Comet Kopff or Comet Wild II to provide the first analysis of the internal chemical makeup of a comet's nucleus.

## NASA Wins Presidential Design Award

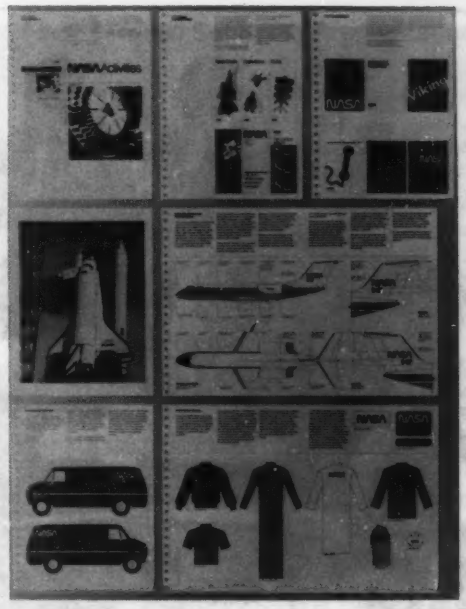
NASA has won the Presidential Design Award for NASA graphics and its visual communications system.

The government-wide awards, presented by President Reagan on Jan. 30, 1985, are administered by the National Endowment for the Arts and recognize excellence in federal design. The NASA project, along with 12 others, was selected from among 91 winners of Federal Design Achievement Awards.

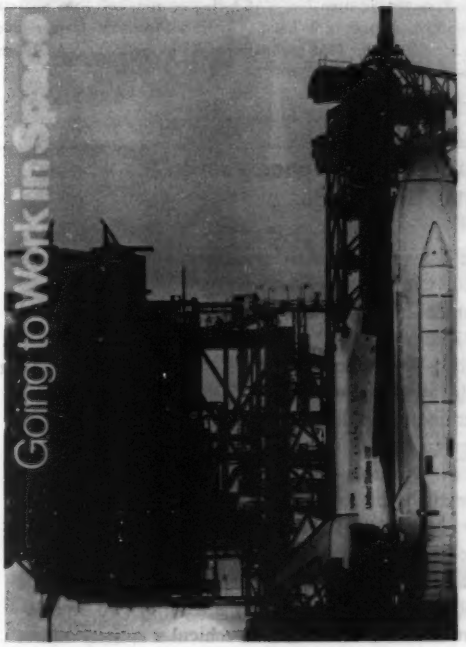
The Presidential Design Awards program was established in December 1983. In his memorandum to heads of departments and agencies, President Reagan said, "The federal government is the nation's single largest builder, printer and user of design services. What we build, print or cause to be manufactured for federal use directly affects every citizen. We must ensure that these investments are cost-effective, well-planned and reflect the standards of excellence which we all expect from our government."

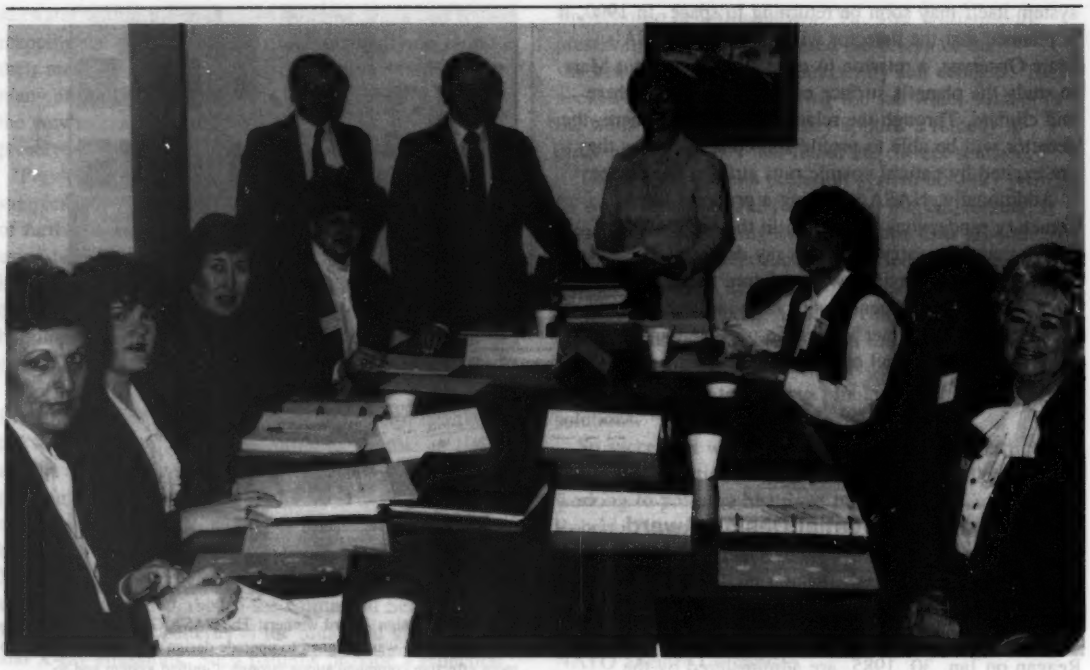
The Presidential Design Awards jury chairman, noted architect I.M. Pei, stated in his jury report, "By far the largest number of entries were submitted under the category of graphic design, ranging from a single postage stamp to a total graphic communications program. Especially noteworthy is the visual communications system developed by the National Aeronautics and Space Administration whose posters, publications and logotype generally maintain a high standard of design which truly captures the spirit and vitality of the space program."

The NASA visual communications program is administered by Robert Schulman, Graphics Coordinator, NASA Headquarters, Washington, D.C.



Presidential Design Award winners: The NASA Graphics Standards Manual (above) was designed to upgrade design standards and develop more effective communications through a unified system and to project a contemporary, businesslike, progressive and forward-looking image through effective use of design. Below, "Going to Work in Space" is the first in a set of three posters celebrating the maiden flight of Space Shuttle Columbia in 1981.





**NASA Correspondence Handbook Workshop Held** — The NASA working group to revise the NASA Correspondence Handbook met at NASA Headquarters on Feb. 7, 1985. Participants seated at the table are, (from the left) Brenda Spencer, Langley Research Center; Sharron Sample, NASA Headquarters Records Management Officer; Joan Keating, Lewis Research Center; Rosemarie Vitagliano, leader of the group and manager of the NASA Administrator's Correspondence and Files Unit; Rochelle Gale, NASA Headquarters; Jewell Norsworthy, Johnson Space Center; and Mary Fouraker, Kennedy Space Center. Standing (from the left) is Ronald Krodel, Langley Management Support Division; Carl Steinmetz, Chief, Records Management Branch at NASA Headquarters and Nina K. Letaw, NASA Records Officer, who has responsibility for NASA correspondence management. Langley's Office Procedures Guide, which incorporates the NASA Correspondence Handbook as a chapter, is being used as a model by the NASA working group to revise the NASA Correspondence Handbook as part of a new NASA Office Procedures Handbook.

## Construction-in-Space Test to Fly Aboard Shuttle This Year

The U.S. efforts toward homesteading in space will continue late this year when astronauts test a NASA experiment aimed at building large structures in orbit.

In December 1985, a structural assembly test called "EASE" — for "Experimental Assembly of Structures in EVA (extravehicular activity)" — will provide fresh insight into the ability of humans to work in space.

The experiment is managed by NASA's Marshall Space Flight Center in Huntsville, Ala.

Essentially the experiment involves six aluminum beams, each 12 feet in length and 4 inches in diameter. Located in the payload bay of the Space Shuttle, the beams will be carried into orbit and continually assembled and disassembled by a team of two Shuttle crew members dressed in extravehicular activity suits.

"In this experiment, astronauts will demonstrate the performance of human beings in orbit as they attempt to build strong, practical structures," said the Marshall Center's Ed Valentine, mission manager for the experiment.

When the team completes the assembly, its shape will always be a tetrahedron — a four-sided pyramid. "This is a first step," said Valentine. "Our ultimate purpose with this experiment is to build structures in space. The ability to move about in space and put beams together into a unified, practical whole has applicability to a number of things under study, such as the Space Station."

The two crewmembers assigned to work with the experiment will be tethered to the payload bay and their movements recorded with videotape and still photographs. The team will link the beams by special connectors at the tips, rather than with the more

traditional Earth-bound method of beam-connecting by nuts and bolts.

"This building approach falls within the class of techniques within the Large Space Structures program called 'erectible' methods," said Valentine. "The other class is the 'deployable' method, but this isn't going to be demonstrated — at least not until 1986 or '87 when we orbit the 'SADE,' or 'Structural Assembly Demonstration Experiment.' It'll be the follow-on experiment to the tetrahedron assembly, and will involve both erectible and deployable methods in constructing a metal truss."

For several years earthly tests of similar experiments have been carried out in Marshall's Neutral Buoyancy Simulator, a million-gallon water tank that provides a sense of weightlessness to people submerged within it and working in space suits.

Historically, EASE has its ties with both the neutral buoyancy tank and the Massachusetts Institute of Technology. "In 1980 the school asked the Marshall Center for use of its tank to perform structural assembly experiments," said Valentine. "When the Shuttle later became operational and NASA began looking at possible flight experiments for it, the school proposed the tetrahedron experiment to NASA Headquarters as a preliminary study to the SADE."

In late 1982 the notions of a first structural assembly test in space coalesced into the experiment now known as EASE. The demonstration is currently scheduled for Shuttle flight 61-C.

After the videotape and still pictures of the test have been returned to Earth for study, the results will be correlated with those found in the neutral buoyancy tank. "Basically we'll time how long it takes to assemble the tetrahedron and how long it takes to take it apart," said Valentine. "Somehow, though, we'd like to be able to measure a human being's productivity in space scientifically. We're not really sure if time measurements are all that are needed to gauge that, so we'll be examining other possible criteria to use in the future."

When the experiment is launched into space this year, it will be accompanied by a structural assembly project managed by the Langley Research Center in Langley, Va. The Marshall Center is responsible for integrating the two experiments, both of which will rest upon a special structure called "MPESS," for "Mission Peculiar Equipment Support Structure."

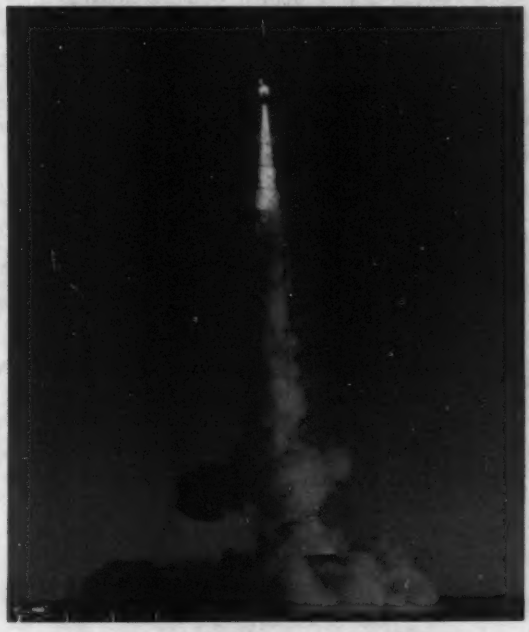
"We think the tetrahedron experiment this year is the beginning of a wide-ranging application of construction in space," said Valentine, "all starting with this relatively modest test called 'EASE'."

## Final Aerobee Sounding Rocket Launched

NASA's successful launch of an Aerobee liquid-fueled sounding rocket from White Sands Missile Range, N.M., on Jan. 17, marked the end of that rocket series. Introduced officially on Sep. 25, 1947, with the first range launch, the firing of Aerobee 1058 was the last of the oldest continuous rocket firing program.

Since 1959, NASA's Sounding Rocket Division has launched 536 Aerobees, 504 successfully — a 97 percent success rate. The Aerobee series was one of the first rockets developed for scientific research in the United States. Because of its reliability, Aerobee became the "workhorse" vehicle for high altitude studies. "Virtually everything that's been done in space research can be attributed to sounding rocket technology," said Maury Dubin, a Goddard physicist who worked extensively in the early sounding rocket program. "The Aerobee and other sounding rocket research precipitated the rise of many disciplines, from astronomy to the upper atmosphere".

The Aerobee program began in 1946, when Applied Physics Laboratory (APL), Johns Hopkins University at Baltimore, Md., suggested to noted scientist Dr. James Van Allen that he determine what existing rockets were available for scientific research, specifically for augmenting high atmospheric studies. Other rockets



Aerobee 1058 lifts off from launch complex 35 at White Sands Missile Range, N.M.

were available, but were deemed too small for the anticipated space research.

Aerojet Engineering Corp. won a contract from the U.S. Navy to develop new scientific sounding rockets; APL was assigned technical direction, and Dr. Van Allen became director of the project. He derived the name Aerobee from the combination of Aerojet and APL's series of Navy missiles, the Bumblebees.

Aerobees were used extensively during the International Geophysical Year (IGY, July 1957-December 1958). They were among the more than 300 instrumented sounding rockets launched from sites around the world and made discoveries regarding the atmosphere, cosmic radiation, auroras and geomagnetism. The IGY was largely an investigation of the natural environment.

The rockets carried instruments into the upper atmosphere for investigations and gathered data from as high as 155 miles. They also flight tested instruments to be used in satellites. Sending instruments in the high atmosphere was one of the principal motives for 20th century rocket development, according to the early rocket design studies of Dr. Robert Goddard, known as the Father of American Rocketry.

The Aerobee rockets consisted of five in a series; 100, 150, 170, 200 and 350. Each rocket carried as many as six different experiments. Cameras, vacuum bottles, mirrors, girds, sensing devices, lenses and many other mechanical units were flown and returned to Earth. Most of the data collected involved transmitting telemetry from the rocket to ground stations during flight and recording data simultaneously.

The final Aerobee payload tested a new spectrograph scheduled for flight on Astro, a NASA ultraviolet astronomy mission. This spectrograph will record extreme ultraviolet dayglow emissions in the Earth's upper atmosphere.

Although the demise of the small, liquid-fueled sounding rocket is imminent, there always will be a need for sounding rockets in general, according to George Kraft, head of Goddard's Flight Support Section. "The small, liquid-fueled rockets aren't economically feasible anymore, compared to their solid-propelled counterparts," Kraft said. "But sounding rockets always will continue to be an important element in NASA's support of the scientific community. They're virtually the only vehicles that can conduct studies in the 25 to 125-mile-high zone of the atmosphere. "Balloons can go only as high as 31 miles and satellites are ineffective lower than 125 miles.

The NASA Sounding Rocket Program is managed by Goddard's Wallops Flight Facility, Wallops Island, Va., where the Suborbital Projects and Operations Directorate is located.

## Applicants for Teacher Flight Exceed 10,000

Some 10,690 teachers have applied for a flight on the Space Shuttle, NASA and the Council of Chief State School Officers announced.

The application period for NASA's Teacher in Space Project closed Feb. 1. The council is in charge of the application and screening process, while the NASA Administrator will choose the teacher who will go into space.

The greatest number of applicants generally came from the most populated states: California, 926; New York, 707; Ohio, 616; Pennsylvania, 573; and Illinois, 519.

All applications are being screened by the council's review panel to eliminate those not meeting the basic requirements. Remaining applications will be forwarded to state review panels which will evaluate the proposals and select two teachers per state by May 1, 1985. Approximately 118 nominees (two per state plus the District of Columbia, Puerto Rico, Virgin Islands, territories and trusts of the United States, and Departments of Defense and State dependent schools) will be forwarded to a national review panel for further evaluation.

All nominees will attend a teacher workshop and orientation program June 24-28, 1985, in Washington, D.C. The workshop is designed to inform the participants of current developments in the aeronautics and space education program. Applicants will undergo further evaluation and screening by the national review panel.

From the state-level nominees, the national review panel will recommend 10 teachers as semifinalists for consideration by the NASA space flight participant evaluation committee. This committee is comprised of seven senior NASA officials who will name the 10 semifinalists in July 1985.

The semifinalists will report to NASA's Johnson Space Center, Houston, for thorough medical examination, in depth briefings and interviews by the NASA evaluation committee. Based on results of the physical examinations and the interviews, the evaluation committee will determine which applicants are qualified to undergo necesary training.

The names of the finalists will be submitted to the NASA Administrator who, along with the evaluation committee, will select the one primary and one backup candidate to undergo training. The specific flight opportunity is under review, however, the goal is to fly the first teacher on a mission in late 1985.

A breakdown of applications by states, territories and government school systems follows:

**Teacher in Space Project Completed Applications**

| | | | |
|---|---|---|---|
| Alabama | 139 | Montana | 62 |
| Alaska | 59 | Nebraska | 115 |
| Arizona | 156 | Nevada | 72 |
| Arkansas | 65 | New Hampshire | 79 |
| California | 926 | New Jersey | 325 |
| Colorado | 231 | New Mexico | 55 |
| Connecticut | 138 | New York | 707 |
| Delaware | 36 | North Carolina | 152 |
| District of Columbia | 10 | North Dakota | 25 |
| Florida | 370 | Ohio | 616 |
| Georgia | 154 | Oklahoma | 158 |
| Guam | 9 | Oregon | 166 |
| Hawaii | 18 | Pennsylvania | 573 |
| Idaho | 45 | Rhode Island | 78 |
| Illinois | 519 | South Carolina | 81 |
| Indiana | 372 | South Dakota | 55 |
| Iowa | 204 | Tennessee | 159 |
| Kansas | 152 | Texas | 413 |
| Kentucky | 130 | Utah | 71 |
| Louisiana | 57 | Vermont | 51 |
| Maine | 65 | Virginia | 222 |
| Maryland | 202 | Washington | 285 |
| Massachusetts | 236 | West Virginia | 122 |
| Michigan | 494 | Wisconsin | 349 |
| Minnesota | 134 | Wyoming | 386 |
| Mississippi | 43 | Puerto Rico | 4 |
| Missouri | 201 | Dependent Schools | 136 |
| | | Total | 10,690 |

## NASA-Wide Equipment Management System Implemented

A new, on-line agency-wide equipment management system is being implemented by the NASA Headquarters Supply and Equipment Branch. With the help of the Headquarters Information Systems Division and equipment management personnel at each NASA installation, the new system will aid in accountability, management and visibility of NASA's 300,000 items of controlled equipment valued more than $5 billion. You may have noticed the new bar-coded tag that identifies controlled equipment.

The NASA Equipment Management System (NEMS) operates independently at each agency installation on IBM 4341 (or equivalent) mainframes, using the ADABAS data base management system. A central data base, scheduled for completion in April 1985, will link together all center data bases and provide intercenter communications (previously impossible with 10 separate systems). The system also will provide a visibility that could allow for the redistribution of NASA's high-value equipment, where possible, in lieu of procuring new items.

NEMS was designed to simplify, standardize and reduce the cost of managing NASA's equipment. One of NEMS' greatest productivity improvements will be achieved using portable laser bar-code scanners for equipment inventories.

In addition to the standard data elements and software, NEMS provides a preprogrammed capability to facilitate dynamic ad hoc reports and additional space and capability for installation unique requirements.

NEMS is currently operational at Ames Research Center, Langley Research Center, Kennedy Space Center (base operations and Shuttle processing contractors), Marshall Space Flight Center and Goddard Space Flight Center. Kennedy (NASA) and Lewis Research Center will become operational this month, with implementation pending at the National Space Technology Laboratories and Jet Propulsion Laboratory.

In the near future, other agency standard systems will take advantage of NEMS data elements. Among these are the calibration/meteorology information system and a General Services Administration inventory reporting system.

Portable laser bar-code scanner is demonstrated at Headquarters.

## Shuttle Mission 51-D — Pre-Launch Profile

**Crew:** Karol J. "Bo" Bobko, Commander
Donald E. Williams, Pilot
Margaret Rhea Seddon, Mission Specialist 1
Jeffrey A. Hoffman, Mission Specialist 2
S. David Griggs, Mission Specialist 3
Sen. Jake Garn (R-Utah), Payload Specialist
Charles D. Walker, Payload Specialist

**Orbiter:** Discovery (OV-103)

**Launch Site:** Kennedy Space Center, Fla., Pad 39A

**Launch Date/Time:** April 12, 1985; 8:04 a.m. EST*

**Orbital Inclination:** 28.45 degrees

**Altitude:** 160 by 245 nm (Direct Insertion)

**Mission Duration:** 5 days 9 minutes*

**Orbits:** 78 full orbits; landing on the 79th

**Landing Date/Time:** April 17, 1985; 8:13 a.m. EST*

**Landing Site:** Kennedy Space Center, Fla., Runway 15

**Payloads:** Telesat-I (Anik)
Syncom IV-3

**Experiments:** Continuous Flow Electrophoresis System (CFES)
American Echo Cardiograph (AFE)
2 Student Experiments:
- Corn Statolith Experiment
- Brain Cells Experiment

2 Getaway Specials:
- Capillary Pump Loop Priming Experiment
- Water Ball Collision and Furnace Experiments

*Subject to change; mission elapsed times are approximate.

### Principal Mission Activity

**Telesat-I (Anik),** a communications satellite owned by Telesat Canada Ltd., will be boosted to geosynchronous orbit by a PAM-D upper stage. This will be the fourth launch of a Telesat from the Space Shuttle. The first one was successfully deployed by the STS-5 crew in November 1982; the second was deployed in June 1983 on STS-7; and the third was deployed on STS 51-A in November 1984. The four spacecraft will provide voice communications and television coverage to a trans-Canadian satellite network.

The third **Syncom IV** satellite carried by the Space Shuttle will be released in a 'roll-out" type deploy, identical to that used for Syncom IV-1 on STS 41-D and Syncom IV-2 on 51-A, and will be boosted to geosynchronous orbit by a Unique Upper Stage. Syncom is a geosynchronous communications satellite by Hughes Communications Services, Inc.

The **Continuous Flow Electrophoresis System** (CFES) is a commercial project of McDonnell Douglas Astronautics Co., St. Louis. It includes a fluid systems module, an experiment control and monitoring module, a sample storage module and a pump/accumulator package along with miscellaneous equipment stored in a standard storage locker. CFES activity will, as on 41-D, use Block Three hardware designed for mass production operations. Block Three hardware replaces the Block Two design flown on STS missions 5, 6, 7 and 8. The new design eliminates the use of collection trays, sample syringes and is totally self-contained. Crew interface will involve activitation and close monitoring of the process. Adjustments and changes will be made as needed for sample proper processing. Sample evaluation will be performed throughout the flight using syringe extractions for testing. Hughes payload specialist Charles D. Walker will conduct the CFES experiments on 51-D.

The **American Flight Echocardiograph** (AFE) instrument will operate within a Shuttle middeck locker. An echocardiograph, using ultrasonic scanning techniques, will be made on one crewmember for each day of the flight. A minimum of four views will be taken from specific areas of the body. AFE will investigate evidence of cardiovascular deconditioning and the response of counter measures of conditioning. The data will be recorded on videotape and analyzed on the ground.

**Two Getaway Specials** will be carried on 51-D:

The **Capillary Pump Loop Priming Experiment,** provided by Goddard Space Flight Center, will investigate the effects of zero-g on a heat transfer system that could be used on future orbiting spacecraft or platforms such as the Space Station.

The **Surface Tension and Viscosity Experiment Alloys, Lead Oxide and Carbon Fiber Experiment,** provided by the Asahi National Broadcasting Co. Ltd., Tokyo, Japan, were first carried on STS 41-G in October 1984. The experiments, unsuccessful on that mission, have been repaired and are being reflown. One experiment is designed to provide clear-cut answers to what happens when a metal or plastic (solid) is allowed to collide with water ball (liquid) in weightlessness. The behavior of the metal or plastic ball and the water ball after collision will be observed on video systems. The other system is designed to produce five kinds of new materials simultaneously in space. The formation of crystals of three metal alloys and two glass composites in five small electrical furnaces in weightlessness will be observed.

Two **Shuttle Student Involvement Program** experiments are scheduled to fly on 51-D:

The **Corn Statolith Experiment** will investigate the effect of weightlessness on the formation of statoliths in plants by exposing plants with capped and uncapped roots to spaceflight. The root caps of the flight and control plants will be examined post-flight by electron microscope for statolith changes. The student experimenter is Sean Amberg of Nebraska. His sponsor is Dr. Harold Papazian from Martin Marietta Aerospace.

The **Brain Cells Experiment** will consist of 300 houseflies contained in a Fly Enclosure Module located in a middeck locker. The experiment will study the impact of weightlessness in brain cells. It is expected to show accelerated aging of the brain cells based on an increased accumulation of age pigment in, and deterioration of, the neurons. Andrew Fras of New York is the student experimenter. Jack Sweeney, University of Southern California Orthopedic Hospital, Los Angeles, is his sponsor.

Technicians perform preflight checks on Telesat I (Anik C-1).

**Summary of Major Activities**

**Flight Day 1**
Launch/orbit insertion
American Flight Echocardiograph (AFE) operations
Continuous Flow Electrophoresis System (CFES) activitation
Remote Manipulator System checkout
Telesat deploy (5:42 p.m. EST)

**Flight Day 2**
Telesat or Syncom deploy (9:02 a.m. EST)
CFES operations
AFE operations

**Flight Day 3**
Backup Syncom deploy opportunity
CFES operations
AFE operations
Waste and supply water dump
Cabin measurements

**Flight Day 4**
AFE operations
CFES operations

**Flight Day 5**
AFE operations
Flight Control System checkout
Reaction Control System hot fire
CFES operations
On-orbit crew press conference (9:04 a.m. EST)

**Flight Day 6**
Landing KSC (orbit 79)



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## NASA Study Analyzes Need of Humans In Space

High above Earth in the next century, a space worker inside an orbiting module solders a wire in place to repair an electrical circuit. Upon finishing, he replaces a malfunctioning cooling pump by joining several electrical and fluid connectors to the new unit. Lastly he turns to a planning schedule to organize tomorrow's work.

He'll be busy: among other duties, he'll have to install an intricate thermocouple in a furnace for a metal alloy experiment. Later he'll remove the biomedical sensors from a fellow worker and from several laboratory animals being tested. After a long day, he'll finally analyze data gathered from an experiment begun eight hours earlier.

This hard-working laborer may not know it, but with every working day he's verifying the conclusions of a NASA study finished decades ago in 1985 — that a human being is essential in space, especially in those activities calling for creative thinking, analysis, planning and fine motor skills.

The extent of automation needed in space has been debated for years. Some have proposed that man is not needed to explore beyond the upper atmospheric limits of Earth, because high-technology machines can — or will eventually — do it as well or better.

But a recently-completed study at NASA's Marshall Space Flight Center in Huntsville, Ala., has shown that an undeniable need exists for both humans and machines in space. "For years," said Marshall's Georg von Tiesenhausen, "we've discussed the need for a human presence in space to balance the presence of machines. This new study, however, defines engineering data that are hard evidence of the human necessity in space."

Von Tiesenhausen was speaking of "The Human Role in Space (THURIS)," a study in which he played a key role. McDonnell Douglas Astronautics Co. was awarded the study contract in 1983, and Marshall is continuing to refine and validate the data in follow-on activities. The contract has been under the management of Marshall's Stephen B. Hall, a human factors engineer experienced in man/machine issues regarding complex space systems.

"The THURIS study gives us a unified picture of how people and machines will work together in orbit or on planetary missions," said Hall. "About a year ago, we completed another study called (ARAMIS) for 'Automation, Robotics and Machine Intelligence Systems.' It examined these automated and artificial intelligence systems to see how they could be used in space. THURIS built upon this earlier work by using some of the same data and techniques."

Selecting from past and future missions, engineers involved in the human role study sifted through thousands of known facts and projected tasks expected of men and women in future missions. After analyzing the multitude of jobs people could do in space, the study reduced this data to 37 generic tasks.

These tasks range from removing and replacing protective coverings around spacecraft to surgically acquiring tissue samples, and from measuring physical dimensions of objects to compensating for tracking errors in fine guidance systems.

A problem facing engineers for future missions is how to allocate tasks to machines, or humans, or both. The THURIS study established three criteria for the allocation of tasks to help system designers decide how man should be involved. "For task allocation, we looked at the performance time, the relative cost, and the technological risk," said Hall. "These criteria became the basis for an objective, measurable method in allocating tasks. The method applies to a broad spectrum of space missions. It was tailored for analyses early in the life of a program when firm data are scarce but decisions can be far-reaching. What we did in the Human Role study was to get away from the old idea of categorizing a system design as either manned or unmanned.

The study analyzed how much each of the 37 generic tasks would benefit from human involvement.

"The human being, of course, is the ultimate robot," said Hall, "and his range of capabilities are tremendous — the ability to recognize different objects, for instance, to feel shapes and textures, and to discriminate odors. He has cognition, memory and so many other capabilities that you couldn't possibly tap all the ones he has.

"Additionally, we were analyzing human limitations — for example, we can't calculate at a high rate like machines, such as those that can compute an orbital trajectory many times a second. This doesn't mean man should be replaced by machines. We do, however, need to understand our capabilities compared to machines in order to use them effectively. They can complement and amplify capabilities, and liberate us from repetitive, routine tasks. They can free us to imagine and to explore new horizons."

To get a general idea of how human roles might benefit various space activities, the study applied human capabilities and limitations against each of the 37 generic tasks. For each activity, man's participation in it

was rated on a scale that ranged from "essential" to "not significant."

One of the 37 tasks, for instance, entitled "Compute Data," was rated not significant since, according to the study, "man will play a negligible role in most data computation." But another task, "Surgical Manipulations," which included such activities as acquiring tissue samples, was scored essential for human involvement and "not appropriate for automation, because it is an activity requiring delicate motor skills and judgment," said the study.

One of the most significant tasks, "Define Procedures/Schedules/Operations," was essential because the 'activity is wholly dependent on man's intellectual capabilities." Human involvement, in fact, was rated beneficial or higher in the majority of the 37 tasks.

Besides the benefit analysis, another THURIS product was an analytical method to help define how man should be used in new space systems. This method objectively compares humans, machines, and certain systems that require combinations of both. The method consists of a short, logical sequence of questions and a set of highly condensed supporting data. The supporting data covers performance times for all 37 generic activities, relative costs for doing those activities with each man/machine combination, and technology availability data. The data were derived during THURIS from past spaceflight experience, tests in simulated space conditions, and engineering analyses. Answers to the sequential questions are put on a worksheet during the analytical method.

"The worksheet is only a tool for system engineers and designers," said Hall, "but the THURS study has provided a set of fundamental data for planners that can be used as a guide for many future activities."

A two-day productivity meeting was held at Boeing Aerospace in Seattle, Dec. 3-4, 1984. The first day was devoted to a discussion of the productivity program, followed by a closed NASA meeting on the second day to review the status of on-going productivity activities at all NASA installations and to discuss future plans for the agency's Productivity Program. NASA participants pictured are (standing, from the left): John Stokes, Langley Research Center; Robert Goetz, Johnson Space Center; C. Howard Robbins, Lewin Warren and Russel Ritchie, Headquarters; Warner Stewart, Lewis Research Center; Gene Guerny, HQ; William Peterson, Ames Research Center; John F. Murphy, HQ; Leo Lunine, Jet Propulsion Laboratory; Thomas Campbell, HQ; J. Phil Click, JPL; Thomas Lee, Marshall Space Flight Center; Charles Pellerin, HQ; Warren Camp, Kennedy Space Center; Jessie Harris, HQ; J. N. Foster, Marshall; John Quann, Goddard Space Flight Center; Fred Felberg, JPL; Edward Richley, Lewis; Wayne Young, Johnson; H. William Wood, HQ; Milton Beheim, Lewis; Richard Peterson, Langley; William Kelly, Johnson; George English, Kennedy; Lynwood P. Randolph, HQ; Richard Reeves, Goddard; Richard Wisniewski, Haggai Cohen and Cecil Rosen, HQ; Glade Woods, National Space Technology Laboratories; Jack Boyd, Ames; and David Braunstein, HQ. Kneeling (from the left) is William Reynolds, Marshall; Charles Boyle, Goddard; and Jerry Hansbrough, Langley.

## Contractor News

Marshall Space Flight Center, Huntsville, Ala., has announced the selection of **Grumman Data Systems Corp.**, Bethpage, N.Y., for negotiations leading to the award of a $42 million five-year contract for a high speed (Class VI) computer system. The firm-fixed price contract will require Grumman to provide hardware, software, documentation and services required to deliver, install and maintain an engineering analysis and data system. The system will be used for scientific and engineering computations in support of Marshall programs with emphasis on analysis of thermal, electrical, loads and structural design characteristics that influence flight vehicle and payload performance. The contract provides for a total lease period, with renewal in periods of one to 12 months, not to exceed 60 months.

Lewis Research Center, Cleveland, has awarded a follow-on contract valued at $32,346,000 to **General Dynamics, Convair Division,** San Diego, Calif. Under terms of the contract General Dynamics will perform operations to erect, test and launch the Atlas Centaur launch vehicles. Additionally, the contract will include support testing and launch of Centaur upper stages to be used on Shuttle missions scheduled for 1986. Modifications of the launch facility for this capability are also included in the contract. The cost-plus-award-fee contract, beginning Jan. 1, 1985, and running through December 1986, is a continuation of work performed under earlier contracts with General Dynamics. Work will be performed at the Eastern Space and Missile Center, Fla. Centaur is a high energy upper stage currently used with expendable boosters to deliver large payloads to geosynchronous orbit. It is expected to add substantially to the Space Shuttle's ability by carrying heavier payloads from low Earth orbit to geosynchronous orbit or interplanetary trajectories.

NASA has awarded a contract to **Stearns Catalytic Corp.**, Denver, Colo., to modify a test stand at the National Space Technology Laboratories in Hancock County, Miss. The modification to the B-2 stand will give NSTL a third test position to static-fire Space Shuttle main engines individually. Value of the fixed-price contract is $2,374,800. The structural, mechanical and electrical modifications will begin no later than March 1985, and are to be completed in approximately one year. Space Shuttle main engine testing has been under way at NSTL since June 1975. The A-1 and A-2 test stands are used for single engine testing of flight and non-flight engines. The B-2 test position was most recently used to certify the Shuttle's main propulsion system in a series of three-engine "cluster" firings. The stand was originally used in the 1960s to flight-certify the first stage of the Apollo/Saturn V space vehicle. The modification design allows the B-2 test position to be returned to the cluster configuration if needed. The additional test position will support projected increases in main-engine test requirements, including increased turbopump production rates. The initial use of the B-2 position will be to test new and overhauled engine turbopumps using a testbed engine.

## Revolutionary Aircraft Engine Demonstrated

A new, revolutionary "convertible" gas turbine engine concept that will enable future rotorcraft to operate either as a rotary or fixed-wing aircraft, capable of attaining speeds equivalent to today's fast commercial transports, has been demonstrated successfully at NASA's Lewis Research Center in Cleveland.

This new convertible engine concept can operate in either turboshaft mode or turbofan mode or in both modes simultaneously.

The demonstration is part of a joint program being conducted by NASA and the Defense Advanced Research Projects Agency (DARPA). The TF-34 engine was modified under contract with the General Electric Co.

Future X-wing (four-bladed) rotorcraft with such an engine will have shaft power to drive its rotor blades allowing it to take off vertically. After reaching the necessary conversion speed — near 200 knots — the transmission of the rotorcraft will be disengaged and the rotor blades will be locked in an "X" configuration to provide wing lift as a fixed-wing aircraft. In 15 to 20 seconds, the engine will convert from shaft to fan mode to power the craft at speeds near .8 mach. Landing will

An artist's concept of a convertible engine rotorcraft.

be accomplished as a rotorcraft after reversing the conversion process.

During the past year, tests have evaluated performance characteristics of the convertible engine. In December 1984, the first transient operations simulating the conversion to and from rotary-wing to fixed-wing flight were accomplished successfully. The conversion was completed within 18 seconds. The engine responded as predicted throughout the conversion.

These tests represent the first successful operation of a 5,000 hp-class convertible engine in both fan and shaft modes and the first dual mode operation for an engine. The convertible engine will make possible a new breed of civil and military high-speed rotorcraft that can operate efficiently from hover to transonic speeds.

## New NASA Publications Available

*The Management of Research Institutions: A Look at Government Laboratories,* NASA SP-481, by Dr. Hans Mark and Arnold Levine, has been published by the NASA Scientific and Technical Information Branch. The book deals with the management of Federal laboratories under conditions of financial stringency. It sketches the history of technology development laboratories and analyzes how they are actually run. Early chapters show in detail how the logic of scientific investigation conjoined with the expansion of industry to ultimately lead to the mission-oriented laboratories spponsored by NASA, the Atomic Energy Commission and the Department of Defense. The publication includes examples from Dr. Mark's experience as Director of Ames Research Center, where he was responsible for major systems procurements. Copies may be obtained from the Superintendent of Documents, U.S. Government printing Office, Washington, D.C. 20402, for $14.00.

*The Geology of the Terrestrial Planets,* NASA SP-469, by Michael Carr, Robert Strom, Stephen Saunders and Donald Wilhelms, has been published by the NASA's Scientific and Technical Information Branch. The book gives a summary of the current knowledge of the geology of the terrestrial planets — Mercury, Venus, Earth, Mars and the moon. A short introductory chapter is included as well as one on asteroids, comets and planet information to provide contextual information for the main chapters. The publication was authored by Michael H. Carr and Donald Wilhelms of the U.S. Geological Survey; Robert Strom, University of Arizona; and Stephen Saunders, NASA Jet Propulsion Laboratory. Copies are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $16.00. GPO stock number is 033-000-00900-3.

*On the Frontier: Flight Research at Dryden, 1946-1981,* NASA SP-4303, by Richard P. Hallion, has been published by the Scientific and Technical Information Branch. This illustrated volume is a history of the Dryden Flight Research Center from its origins during World War II until 1981. Flight testing and flight research aircraft are emphasized, as well as interaction with the military services. Although Dryden is frequently thought of as an aircraft center, many of its activities have been in direct support of the space flight program, starting with the operation of experimental aircraft in the upper reaches of the atmosphere, where they must be controlled much like spacecraft. Copies may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $15.00. GPO stock number is 033-000-00893-7.

## Awards Corner

**Dr. Arnauld Nicogossian,** director of the Life Sciences Division in the Office of Space Science and Applications at NASA Headquarters, recently received the American Astronautical Society's Melbourne W. Boynton Award for his development of innovative medical policies and plans in support of successful Space Shuttle flights, and for his extensive contributions to the biomedical aspects of flight. The award is presented annually to a deserving physician in memory of Boynton, a World War II Army Air Corps flight surgeon who dedicated his career to flight safety and survival.

**Michael C. Garula,** computer systems analyst in the Business Data Systems Division, Langley Research Center, received a Langley Suggestion Award for the "mechanized preparation of SF52, Request for Personnel Action." It was the first Langley suggestion to receive approval from the Office of Management and Budget for government-wide use. The SF52 is a widely-used government form, usually initiated by an employee's

supervisor, and involves such personnel actions as requests for new positions, promotions and changes in jobs or duties. The $1,000 award was presented by center director Richard H. Petersen on Jan. 9.

Michael C. Garula (left) receives Langley Suggestion Award from Richard H. Petersen, center director.

## Crews For First Vandenberg Mission, DOD Flight Named

NASA has announced astronaut crews for two upcoming Department of Defense Space Shuttle missions including the first from Vandenberg Air Force Base, Calif.

Veteran Space Shuttle commander Robert L. Crippen (Capt., USN) will head the crew of mission 62-A, scheduled for launch no earlier than Jan. 29, 1986, from Vandenberg. Other crew members named include pilot Guy S. Gardner (Lt. Col., USAF) and mission specialists Dale A. Gardner (Cdr., USN), Jerry L. Ross (Maj., USAF) and R. Michael Mullane (Lt. Col., USAF).

Crippen will be making his fifth shuttle flight, the fourth as commander. He flew with astronaut John Young on the maiden flight of Space Shuttle Columbia in April 1981, and was commander of STS-7, 41-C and 41-G. Dale Gardner will be making his third trip into space, having previously served as a mission specialist on STS-8 and 51-A. Mullane flew previously as a mission specialist on mission 41-D. Guy Gardner and Ross will be making their first trips into space.

Also announced was the crew for mission 51-J, scheduled for launch from the Kennedy Space Center, Fla. in September 1985. Karol J. Bobko (Col., USAF) will be mission commander. Other crew members include pilot Ronald J. Grabe (Lt. Col., USAF) and David C. Hilmers (Maj., USMC) and Robert L. Stewart (Col., USA), mission specialists.

## What's New in NASA Radio and Television Programming

Some important changes and additions have been made to NASA's ongoing radio service. The 4½-minute "Space Story" will now be broadcast once a week via satellite to all major radio networks. The satellite distribution makes it possible to update or change programs, if necessary, and to inform stations quickly of upcoming important events or breaking news stories. The new system will eventually replaced the tape-and-mail distribution, reach a larger audience and reduce costs.

At the same time a new Broadcast News Service has begun using a telephone feed for breaking news stories. By calling 202/737-6911, a station can record an actuality or interactive interview for use in their news broadcast. The NASA Space Story can be heard on the NASA satellite on Fridays at 2:00 p.m. EST.

Radio programs released in February:

**Space Story** (4½-minute programs):

"U.S./Soviet Cooperation in Space" (featuring James M. Beggs and Kenneth S. Pedersen, NASA Headquarters)
"Search and Rescue Satellites" (featuring Fred Flatow, Goddard Space Flight Center)
"Getting Factories Off the Ground" (featuring James M. Beggs)
"Cosmic Background Explorer" (featuring Dr. John Mather, Goddard Space Flight Center)

**Special Report** (14½-minute program):

"A Look Ahead" (featuring James M. Beggs, NASA Administrator)

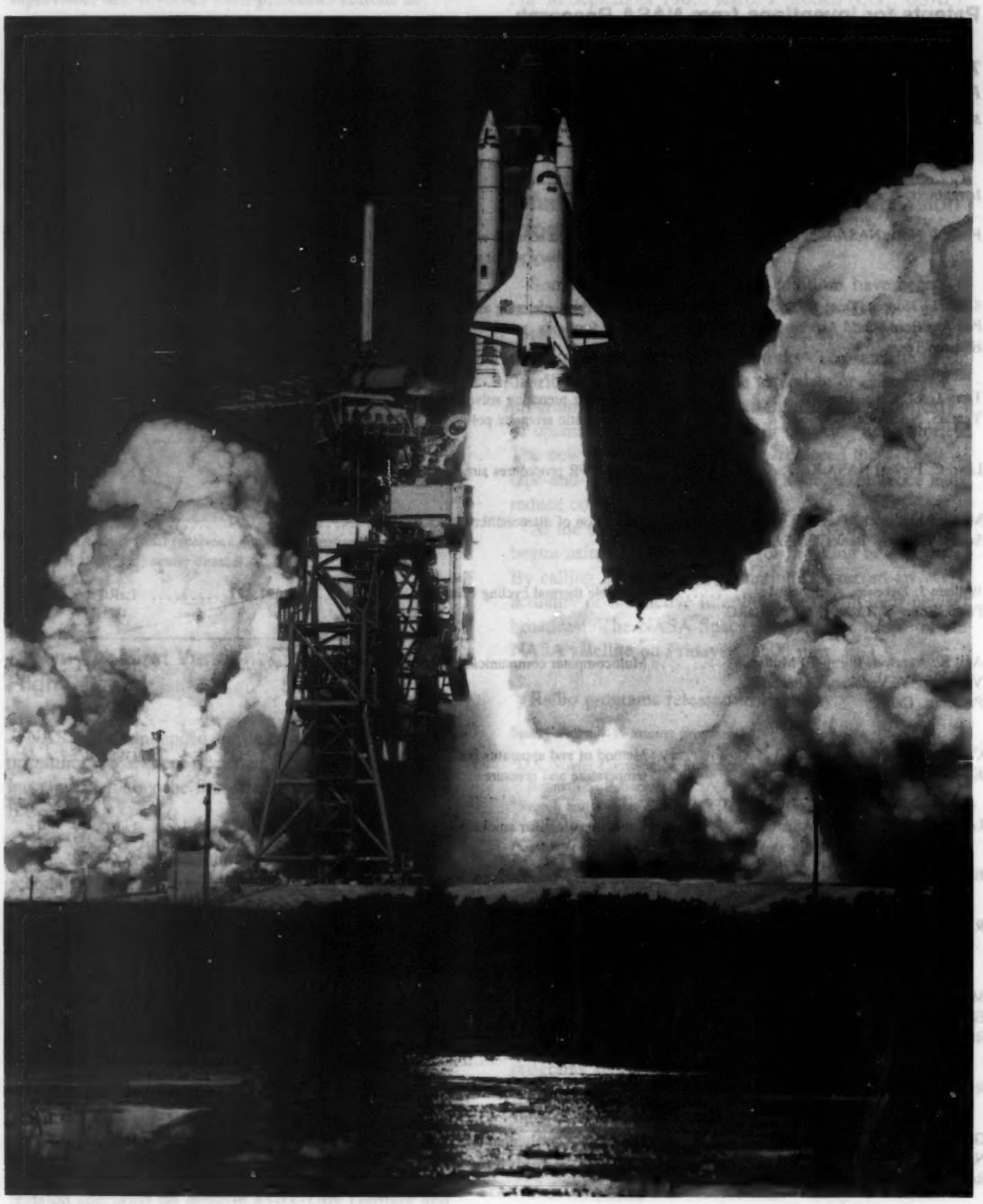
NASA's "Aeronautics and Space Report" television series has also undergone major changes. A 14½-minute "magazine" format replaces the monthly 4½-minute programs and will be released quarterly. The first videotape was completed and mailed to television stations at the end of January. Three-quarter-inch videotapes are available at each center Public Affairs Office. This first release includes four separate features:

- XV-15 Tiltrotor
- A story dealing with the possibility of a permanent lunar base.
- Food for Space — a look at space food preparation yesterday and today.
- 1984 Space Shuttle Highlights

## Patents for Inventions from NASA Research

*The Office of General Counsel, NASA Headquarters, announces the following U.S. patents have been issued by the U.S. Patent Office and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.*

| Inventor(s) & Employer | Title | Patent No. | Installation |
|---|---|---|---|
| Frank J. Nola, NASA/MSFC | Solar powered actuator with continuously variable auxiliary power control | 4,489,243 | MSFC |
| Sonne L. Hooper, Driel Selzer, Pan American World Airways, Houston Texas | Self-charging metering and dispensing device for fluids | 4,488,663 | MSFC |
| Terry L. St. Clair, David A. Yamaki, NASA/LaRC | Process for preparing solvent resistant, thermoplastic aromatic poly(imidesulfone) | 4,489,027 | LaRC |
| Loyd C. Parker, NASA/KSC | Inflight IFR procedures simulator | 4,490,117 | KSC |
| Michael J. Mirtich, James S. Sovey, Bruce A. Banks, NASA/LeRC | Deposition of diamondlike carbon films | 4,490,229 | LeRC |
| William J. Debnam, Archibald L. Fripp, Roger K. Crouch, NASA/LaRC | Reusable thermal cycling clamp | 4,491,427 | LaRC |
| Anil K. Agrawal, Philip G. Mullen, Vivatvong V. Vadakan, Caltech/JPL, Pasadena, Calif. | Multicomputer communication system | 4,493,021 | NRO-JPL |
| Charles L. Korb, James E. Kalshoven, NASA/GSFC | Method of and apparatus for measuring temperature and pressure | 4,493,553 | GSFC |
| Leonard M. Weinstein, NASA/LaRC | Continuous laminar smoke generator | 4,493,211 | LaRC |
| Bruce A. Banks, NASA/LeRC | Diamondlike flake composites | 4,495,044 | LeRC |
| Richard W. Lauver, NASA/LeRC | Chemical approach for controlling nadimide cure temperature and rate | 4,495,339 | LeRC |
| Marvin Kravitz, Larry Freedman, Elmer H. Fredd, Dan E. Denef, RCA Corp., Princeton, N.J. | Television camera video level control system | 4,495,520 | MSC |
| Raymond D. Whipple, NASA/LaRC | Extended moment arm anti-spin device | 4,496,122 | LaRC |
| George M. Fohlen, John A. Parker, NASA/ARC, Indra K. Varma, National Research Council, Washington, D.C. | Phosphorus-containing imide resins | 4,496,701 | ARC |



**51-C Liftoff**—Space Shuttle Discovery lifts off at 2:50 p.m. EST, Jan. 24, 1985, from Pad 39A at Kennedy Space Center, Fla. The crew for the first dedicated Department of Defense mission was Thomas K. Mattingly II (Capt., USN), commander; Loren J. Shriver (Lt. Col., USAF), pilot; Ellison F. Onizuka (Maj., USAF) and James F. Buchli (Lt. Col., USMC), mission specialists; and Gary E. Payton (Maj., USAF), payload specialist. The four-day flight ended with a landing at Kennedy on Jan. 27.

## 1985 Launch Activity

### Space Shuttle Launches

| Date | Mission | Orbiter | Launch Site* | Remarks |
|---|---|---|---|---|
| Jan. 24 | 51-C | Discovery (OV-103) | KSC | Dedicated Department of Defense flight; successful launch; KSC landing Jan. 27. |
| April 12 | 51-D | Discovery (OV-103) | KSC | Payload: Syncom IV-3; Telesat-I. |
| April 30 | 51-B | Challenger (OV-099) | KSC | Payload: Spacelab 3. |
| May 30 | 51-G | Discovery (OV-103) | KSC | Payload: Spartan-I, Telstar 3-D, Morelos-A, Arabsat-A. |
| July 9 | 51-F | Challenger (OV-099) | KSC | Spacelab 2. |

### Satellite Deployments from the Shuttle

| Date | Satellite | Deployment Device/ Upper Stage** | Shuttle, Mission | Remarks |
|---|---|---|---|---|
| April 12 | Telesat-I | PAM-D | 51-D | Canadian communications. |
| April 13 | Syncom IV-3 | UUS | 51-D | Hughes communications. |
| May 30 | Morelos-A | PAM-D | 51-G | Mexican communications. |
| May 31 | Arabsat-A | PAM-D | 51-G | Saudi Arabian communications. |
| June 1 | Telestar 3-D | PAM-D | 51-G | AT&T communications. |
| June 2 | Spartan 101 | RMS | 51-G | NASA experiment structure. |

### Expendable Launches

| Date | Mission | Launch Vehicle | Launch Site* | Remarks |
|---|---|---|---|---|
| March 22 | Intelsat VA-F10 | Atlas Centaur | ESMC | Intelsat communications; launch successful. |
| 2nd Qtr. | AF-16 | Scout | WFF | U.S. Air Force. |
| 2nd Qtr. | Navy-22 | Scout | WSMC | U.S. Navy. |
| May 5 | Intelsat VA-C | Atlas Centaur | ESMC | Intelsat communications. |
| Oct. 3. | Intelsat VA-D | Atlas Centaur | WSMC | Intelsat communications. |
| November | NOAA-G | Atlas | WSMC | National Oceanic and Atmospheric Administration weather satellite. |
| 3rd Qtr. | Navy-23 | Scout | WSMC | U.S. Navy |
| 3rd Qtr. | AF-17 | Scout | WFF | U.S. Air Force. |
| December | GOES-G | Delta | ESMC | NOAA environmental satellite. |
| 4th Qtr. | San Marco | Scout | SMR | NASA cooperative with Italy. |

* **Launch Sites:** KSC — Kennedy Space Center, Fla.; ESMC — Eastern Space and Missile Center, Fla.; SMR — San Marco Range, Indian Ocean; WSMC — Western Space and Missile Center, Vandenberg Air Force, Base, Calif.; WFF — Wallops Flight Facility, Wallops Island, VA.

** **Upper Stages:** IUS — Inertial Upper Stage; PAM-D — Payload Assist Module; UUS — Unique Upper Stage; RMS — Remote Manipulator System.

# Another Dividend from Air and Space

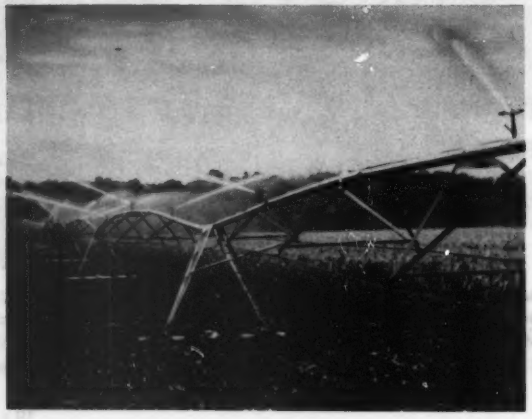
NASA
National Aeronautics and Space Administration

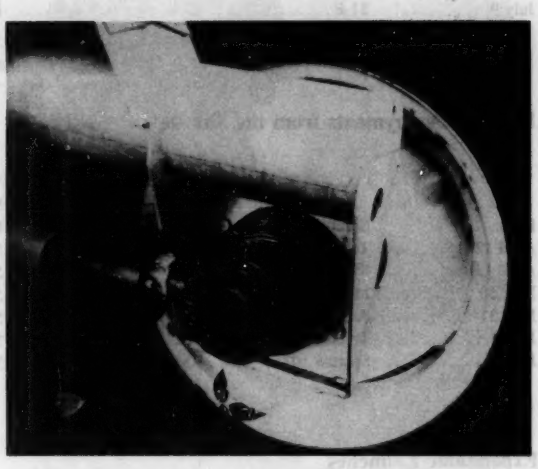
**Research and development in aeronautics and space have provided numerous benefits for all Americans — and at a tiny percentage of the tax dollar. Here is an example:**

### Irrigation System

Shown below is a Zimmatic center pivot agricultural irrigation system built by Lindsay Manufacturing Co., Lindsay, Neb. Systems like this one are composed of multiple lengths of water pipe and spray nozzles supported by wheeled towers such as the one at right. The whole system rotates around a center pivot, watering hundreds of acres — depending on the number of tower units — in a single revolution. Each three-ton tower has its own electric motor; power is transmitted to the wheels by individual gear boxes (upper right) that incorporate NASA lubrication technology to protect them from wear and heat stress.

Under contract with Marshall Space Flight Center, Midwest Research Institute compiled a Lubrication Handbook intended as a reference source for designers and manufacturers of aerospace hardware and crews responsible for maintenance of such equipment. The handbook details the chemical and physical properties, applications, specifications and test procedures for some 500 liquid and solid lubricants used by companies in the aerospace industry.





Lindsay engineers learned of the handbook through the NASA publication *Tech Briefs* and used it for supplemental information in redesigning gear boxes for their center pivot systems. In the new design, gears are immersed in NASA-developed lubricants that provide wearing surfaces and bearings with low-friction protective coatings. The NASA information helped reduce the amount of lubricant required and allowed selection of comparable but less expensive lubricants. The Lubrication Handbook has become a permanent part of the company's technical library, used frequently for decisions on lubrication problems, for information on specific greases, temperatures and compatibilities, and for recommending oil brands to dealers.

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.